CRUSADER HOWITZER AND RESUPPLY VEHICLE

Army ACAT ID Program

Total Number of Systems:	480
Total Program Cost (TY$):	$11,173.9M
Average Unit Cost (TY$):	$23.28M
Full-rate production:	4QFY08

Prime Contractor

United Defense Limited Partnership (UDLP)

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The Crusader system is the Army's next-generation, 155mm, Self-Propelled Howitzer (SPH) and its companion re-supply vehicle, either tracked (RSV-T) or wheeled (RSV-W). Crusader will be the indirect fire support system for ***dominant maneuver*** armored and mechanized forces of the U.S. Army's Counterattack Corps.

The Crusader SPH will employ Advanced Solid Propellant Armament using a modular propellant charge system, auto-settable multi-option fuze, automated ammunition handling, GPS-based position location and azimuth reference system, and improved mobility and RAM. The SPH is required to deliver unassisted munitions at ranges to 30 kilometers and assisted munitions to 40 kilometers, provide a maximum rate of fire of 10 to 12 rounds per minute for 3 to 5 minutes and a sustained rate of 3 to 6 rounds per minute, have the agility and mobility to keep up with the supported maneuver force of M1 tanks and Bradley fighting vehicles, and to complete a survivability move of 750 meters within 90 seconds of identifying a potential threat. There will be an equal mix of RSV-Ts and RSV-Ws with automated ammunition and fuel re-supply functions and GPS-based navigation system. The SPH and RSV-T will each have a crew of three to replace the four and five crewmen, respectively, currently on the Paladin and the M992A1 Field Artillery Ammunition Support Vehicle. RSV(W) will have a two-man crew.

BACKGROUND INFORMATION

The Crusader SPH and RSV program, formerly the Advanced Field Artillery System (AFAS) and Future Ammunition Re-supply Vehicle (FARV) began in 1992. Crusader Operational Requirements Documents were approved in June 1993. In November 1994, the program completed a successful Defense Acquisition Board Milestone I review and entered the Program Definition and Risk Reduction (PDRR) Phase.

In March 1996, the Army decided to terminate liquid propellant development because of higher than expected technical development risks and the expectation that the solid propellant alternative could meet key performance parameter requirements at lower cost and less risk. In 1997, a decrement in program funding caused the Crusader program manager to revise the Acquisition Program Baseline (APB) and slip the Milestone II review to 2001.

In 1QFY00, the program again restructured to address software development/integration problems, a Congressional appropriations FY00 reduction, and a change in the Chief of Staff of the Army's transformation vision. Crusader re-entered the preliminary design phase to make it lighter (38 and 42 tons per vehicle) enabling both C-5s and C-17s to transport two SPHs without weight waivers. The program restructure included an RSV(W) with an automated re-supply module mounted on a PLS carrier. Crusader has also joined the Abrams program in seeking a common engine. On September 20, 2000 Honeywell Engine and Systems was selected to develop an LV100 turbine engine suitable for both systems and Allison was picked to build a X5060 transmission for Crusader. The Milestone II Review slipped to 3QFY03, with the IOT&E and FUE in 2008.

TEST & EVALUATION ACTIVITY

In August 2000, DOT&E approved a Crusader Test and Evaluation Master Plan (TEMP) that reflects the new APB and updates Crusader Critical Operational Issues and Criteria (COIC) to include criteria for platoon, battery, and battalion-level mission accomplishment. The approval memorandum requires a revised TEMP for Milestone II to update the Live Fire Test and Evaluation (LFT&E) strategy, vehicle designs, and the power train development.

Since February 2000, the Self-Propelled Howitzer-1 Emulator (SPH1E) has been undergoing checkout, propellant handling, and firing tests at Yuma Proving Ground. SPH1E includes the actual chassis, armament, and ammunition handling equipment hardware of a "heavy" Crusader prototype with emulation electronics and software, and will be used to demonstrate MS II exit criteria and Key Performance Parameters (KPP) in FY01. UDLP is integrating crew stations, armament and ammunition handling hardware, electronics, and tactical software intended for the first full-up prototypes of the heavy system into a Crusader Integrated Test Station (CITS). CITS will be used to exercise fire missions (inert charges and rounds), re-supply, upload/download, and inventory management functions for both the SPH and RSV.

In 1QFY00, prior to the Crusader program restructuring, the LFT&E IPT completed initial planning for the Live Fire Vulnerability Test activities for the EMD and LRIP periods. The proposed test program will continue to build upon the PDRR phase Engineering Development Test of Vulnerability Reduction Measures (EDT/VRM) test program by continuing component, substructure and compartmentation testing. The first full-scale structure testing of an SPH ballistic hull and turret (BH&T) and a nonfunctional mission equipment structure from a RSV(T) will be a key feature of the early EMD testing. The LFT program will culminate with a full-up, system-level test with a total of 30

firings against three operational vehicles (19 firings against two SPHs and 11 against an RSV(T)). Additional tests will involve a production-representative RSV(T) structure (similar to the early EMD SPH BH&T test). Following the restructuring of the Crusader program, DOT&E and the Army agreed to postpone further development of the LFT&E strategy until after key decisions affecting the re-design of the SPH and RSV(T), and the design of the new RSV(W) were finalized in 4QFY00.

The Crusader program continued EDT/VRM during FY00. Those activities included the Survivability Test Section (STS) experiment that simulated the effects of a propellant compartmentation event. The experiment provided engineering data to the designers of the SPH propellant bustle developing blow-off panels and compartment designs to protect the crew from fires and low-level explosions in the propellant stowage area. The EDT/VRM program is identified in the TEMP as a key element of the LFT&E strategy and will serve as a significant data source for the vulnerability evaluation.

TEST & EVALUATION ASSESSMENT

Key program management areas of concern throughout the program's life are software development, firing precision, tube wear life, nuclear survivability, and reliability. DOT&E includes performance and reliability of the laser ignition and tube cooling systems as major watch areas. Additionally, this is the first U.S. field artillery system to incorporate an automated ammunition and fuel loading and transfer system. Developing this computer-driven, mechanical system and the re-supply vehicle self-propelled howitzer docking system (a fuel and ammunition transfer boom) will be a greater challenge than developing a traditional howitzer and re-supply ammunition-handling system, and is also likely to affect Crusader's overall reliability.

Since the MS II review is scheduled before system-level prototypes of the lighter Crusader have been built or tested, we will have to rely on sub-system tests to demonstrate the exit criteria and on modeling and simulation to forecast system and force-level performance, particularly in the mobility arena. The program is attempting to maximize use of prototype sub-systems built for the original Crusader design to test key performance areas. ATEC plans to conduct an Early User Experiment (EUE) with the Crew Station Trainer and CITS to observe the soldier-machine interface, objective-path software, and ammunition handling sub-systems executing upload, rearm, and firing operations. Although CITS can demonstrate partial integration of key sub-systems, lack of prototypes will make an assessment of system integration risks and reliability more difficult.

Weight reduction initiatives include the new engine and transmission, use of new materials, reduced width and length, modular armor, and a reduced payload. Key areas to watch during the re-design and prototype development include the parallel Abrams-Crusader Common Engine and drive train development, design margin of safety, and material properties of SPH titanium armament, aluminum drive train, and composite materials components. These initiatives increase the program's technical, cost and schedule risk.

LFT&E concerns are threefold. First, a completed LFT&E plan for the re-designed system must replace the LFT&E assumptions in the current TEMP. This effort will be completed in early CY01 as more system definition takes place. Second, sufficient test assets must be programmed to assure adequate vulnerability characterization and crew survivability assessment. Finally, simulation models must be leveraged that have been adequately verified, validated, and accredited in order to maximize understanding and fill in test gaps as much as possible.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

The restructure of the Crusader program has resulted in significant changes to the T&E strategy. Without prototypes at MS II coupled with parallel development of the power pack extending into EMD, testing will focus on major sub-systems that will not be completely integrated until the full system enters EMD. Despite this challenge, the early involvement in T&E by DOT&E and ATEC has ensured that a realistic test approach was included in the restructured Crusader program and should be sufficient to test the system, barring additional major changes to the program.